

**What is claimed is:**

1. A crystalline composition comprising an amount of  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{CaO}$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{TiO}_2$ ,  $\text{K}_2\text{O}$ ,  $\text{P}_2\text{O}_5$ ,  $\text{Cr}_2\text{O}_3$ ,  $\text{ZnO}$ ,  $\text{MgO}$ ,  $\text{Na}_2\text{O}$ ,  $\text{Li}_2\text{O}$ ,  $\text{CeO}_2$ ,  $\text{ZrO}_2$  and  $\text{MnO}_2$ .

2. The crystalline composition of claim 1 further comprising an amount of 35.0 - 43.0 percent of  $\text{SiO}_2$ , 29.0 - 36.0 percent of  $\text{Al}_2\text{O}_3$ , 1.4 - 4.1 percent of  $\text{Fe}_2\text{O}_3$ , 16.0 - 21.0 percent of  $\text{CaO}$ , 1.3 - 15.2 percent of  $\text{TiO}_2$ , 0.6 - 8.9 percent of  $\text{K}_2\text{O}$ , 1.4 - 6.8 percent of  $\text{P}_2\text{O}_5$ , 0 - 6.0 percent of  $\text{Cr}_2\text{O}_3$ , 0 - 11.2 percent of  $\text{ZnO}$ , 0 - 1.5 percent of  $\text{MnO}_2$ , 0 - 10.0 percent of  $\text{MgO}$ , 0 - 10.2 percent of  $\text{Na}_2\text{O}$ , 0 - 5.0 percent of  $\text{CeO}_2$ , 0 - 5.0 percent of  $\text{ZrO}_2$  and 0 - 10.2 percent of  $\text{Li}_2\text{O}$  by weight.

3. The crystalline composition of claim 1, further comprising an amount of 35.0 - 57.0 percent of  $\text{SiO}_2$ , 15.0 - 36.0 percent of  $\text{Al}_2\text{O}_3$ , 1.4 - 10.0 percent of  $\text{Fe}_2\text{O}_3$ , 15.0 - 22.0 percent of  $\text{CaO}$ , 0.6 - 15.2 percent of  $\text{TiO}_2$ , 0.3 - 11.0 percent of  $\text{K}_2\text{O}$ , 1.4 - 6.8 percent of  $\text{P}_2\text{O}_5$ , 0 - 6.0 percent of  $\text{Cr}_2\text{O}_3$ , 0 - 11.2 percent of  $\text{ZnO}$ , 0 - 11.5 percent of  $\text{MnO}_2$ , 0 - 10.0 percent of  $\text{MgO}$ , 0 - 10.2 percent of  $\text{Na}_2\text{O}$ , 0 - 5.0 percent of  $\text{CeO}_2$ , 0 - 5.0 percent of  $\text{ZrO}_2$  and 0 - 10.2 percent of  $\text{Li}_2\text{O}$  by weight.

4. The poly-crystalline composition of claim 1, wherein the poly-crystalline composition is a non porous poly-crystalline composition.

5. The poly-crystalline composition of claim 1, wherein the density of the poly-crystalline composition is in the range of  $2.5 \times 10^3$  to  $2.9 \times 10^3 \text{ kg/m}^3$ .

6. A poly-crystalline product comprising an amount of  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{CaO}$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{TiO}_2$ ,  $\text{K}_2\text{O}$ ,  $\text{P}_2\text{O}_5$ ,  $\text{Cr}_2\text{O}_3$ ,  $\text{ZnO}$ ,  $\text{MgO}$ ,  $\text{Na}_2\text{O}$ ,  $\text{Li}_2\text{O}$ ,  $\text{CeO}_2$ ,  $\text{ZrO}_2$  and  $\text{MnO}_2$ .

7. The poly-crystalline product of claim 6, further comprising an amount of 35.0 - 43.0 percent of  $\text{SiO}_2$ , 29.0 - 36.0 percent of  $\text{Al}_2\text{O}_3$ , 1.4 - 4.1 percent of  $\text{Fe}_2\text{O}_3$ , 16.0 - 21.0 percent of  $\text{CaO}$ , 1.3 - 15.2 percent of  $\text{TiO}_2$ , 0.6 - 8.9 percent of  $\text{K}_2\text{O}$ , 1.4 - 6.8 percent of  $\text{P}_2\text{O}_5$ , 0 - 6.0 percent of  $\text{Cr}_2\text{O}_3$ , 0 - 11.2 percent of  $\text{ZnO}$ , 0 - 1.5 percent of  $\text{MnO}_2$ , 0 - 10.0 percent of  $\text{MgO}$ , 0 - 10.2 percent of  $\text{Na}_2\text{O}$ , 0 - 5.0 percent of  $\text{CeO}_2$ , 0 - 5.0 percent of  $\text{ZrO}_2$  and 0 - 10.2 percent of  $\text{Li}_2\text{O}$  by weight.

8. The crystalline product of claim 6, further comprising an amount of 35.0 - 57.0 percent of  $\text{SiO}_2$ , 15.0 - 36.0 percent of  $\text{Al}_2\text{O}_3$ , 1.4 - 10.0 percent of  $\text{Fe}_2\text{O}_3$ , 15.0 - 22.0 percent of  $\text{CaO}$ , 0.6 - 15.2 percent of  $\text{TiO}_2$ , 0.3 - 11.0 percent of  $\text{K}_2\text{O}$ , 1.4 - 6.8 percent of  $\text{P}_2\text{O}_5$ , 0 - 6.0 percent of  $\text{Cr}_2\text{O}_3$ , 0 - 11.2 percent of  $\text{ZnO}$ , 0 - 11.5 percent of  $\text{MnO}_2$ , 0 - 10.0 percent of  $\text{MgO}$ , 0 - 10.2 percent of  $\text{Na}_2\text{O}$ , 0 - 5.0 percent of  $\text{CeO}_2$ , 0 - 5.0 percent of  $\text{ZrO}_2$  and 0 - 10.2 percent of  $\text{Li}_2\text{O}$  by weight.

9. The poly-crystalline product of claim 6, wherein the poly-crystalline product is a non porous poly-crystalline product.

10. The poly-crystalline product of claim 6, wherein the density of the poly-crystalline composition is in the range of  $2.5 \times 10^3$  to  $2.9 \times 10^3 \text{ kg/m}^3$ .

11. A process for producing a poly-crystalline composition comprising the steps of:

a. Mixing an ash particle with at least one glass forming agent and at least one crystallization catalyst,

b. Melting said ash particle, said at least one glass forming agent and said at least one crystallization catalyst to form a mixture; and

c. Cooling the resulting mixture to ambient temperature so as to form a homogenous, non-porous poly-crystalline product comprising  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{CaO}$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{TiO}_2$ ,  $\text{K}_2\text{O}$ ,  $\text{P}_2\text{O}_5$ ,  $\text{Cr}_2\text{O}_3$ ,  $\text{ZnO}$ ,  $\text{MgO}$ ,  $\text{Na}_2\text{O}$ ,  $\text{Li}_2\text{O}$ ,  $\text{CeO}_2$ ,  $\text{ZrO}_2$  and  $\text{MnO}_2$ .

12. The process of claim 11; wherein in step C the poly-crystalline product further comprising an amount of 35.0 - 43.0 percent of  $\text{SiO}_2$ , 29.0 - 36.0 percent of  $\text{Al}_2\text{O}_3$ , 1.4 - 4.1 percent of  $\text{Fe}_2\text{O}_3$ , 16.0 - 21.0 percent of  $\text{CaO}$ , 1.3 - 15.2 percent of  $\text{TiO}_2$ , 0.6 - 8.9 percent of  $\text{K}_2\text{O}$ , 1.4 - 6.8 percent of  $\text{P}_2\text{O}_5$ , 0 - 1.5 percent of  $\text{Cr}_2\text{O}_3$ , 0 - 11.2 percent of  $\text{ZnO}$ , 0 - 1.5 percent of  $\text{MnO}_2$ , 0 - 10.0 percent of  $\text{MgO}$ , 0 - 10.2 percent of  $\text{Na}_2\text{O}$ , 0 - 5.0 percent of  $\text{CeO}_2$ , 0 - 5.0 percent of  $\text{ZrO}_2$  and 0 - 10.2 percent of  $\text{Li}_2\text{O}$  by weight.

13. The process of claim 11, wherein in step C the poly-crystalline product further comprising an amount of 35.0 - 57.0 percent of  $\text{SiO}_2$ , 15.0 - 36.0 percent of  $\text{Al}_2\text{O}_3$ , 1.4 - 10.0 percent of  $\text{Fe}_2\text{O}_3$ , 15.0 - 22.0 percent of  $\text{CaO}$ , 0.6 - 15.2 percent of  $\text{TiO}_2$ , 0.3 - 11.0 percent of  $\text{K}_2\text{O}$ , 1.4 - 6.8 percent of  $\text{P}_2\text{O}_5$ , 0 - 6.0 percent of  $\text{Cr}_2\text{O}_3$ , 0 - 11.2 percent of  $\text{ZnO}$ , 0 - 11.5 percent of  $\text{MnO}_2$ , 0 - 10.0 percent of  $\text{MgO}$ , 0 - 10.2 percent of  $\text{Na}_2\text{O}$ , 0 - 5.0 percent of  $\text{CeO}_2$ , 0 - 5.0 percent of  $\text{ZrO}_2$  and 0 - 10.2 percent of  $\text{Li}_2\text{O}$  by weight.

14. The process of claim 11, wherein said at least one glass forming agent is selected from the group consisting of  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Li}_2\text{O}$ ,  $\text{MgO}$ ,  $\text{Na}_2\text{O}$ ,  $\text{CaO}$  and  $\text{K}_2\text{O}$ .

15. The process of claim 11, wherein said at least one crystallization catalyst is selected from the group consisting of titanium dioxide, chromium oxide, zinc oxide, cerium dioxide, manganese dioxide and zirconium dioxide.

16. The process of claim 11, wherein in step B the ash particle, the at least one glass forming agent and the at least one crystallization catalyst are heated at the temperature range of 1400°C - 1600°C.

17. An article of manufacture comprising  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{CaO}$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{TiO}_2$ ,  $\text{K}_2\text{O}$ ,  $\text{P}_2\text{O}_5$ ,  $\text{Cr}_2\text{O}_3$ ,  $\text{ZnO}$ ,  $\text{MgO}$ ,  $\text{Na}_2\text{O}$ ,  $\text{Li}_2\text{O}$ ,  $\text{CeO}_2$ ,  $\text{ZrO}_2$  and  $\text{MnO}_2$ .

18. The article of manufacture of claim 17, further comprising an amount of 35.0 - 43.0 percent of  $\text{SiO}_2$ , 29.0 - 36.0 percent of  $\text{Al}_2\text{O}_3$ , 1.4 - 4.5 percent of  $\text{Fe}_2\text{O}_3$ , 6.0 - 25.0 percent of  $\text{CaO}$ , 1.3 - 15.2 percent of  $\text{TiO}_2$ , 0.6 - 8.9 percent of  $\text{K}_2\text{O}$ , 1.4 - 6.8 percent of  $\text{P}_2\text{O}_5$ , 0 - 6.0 percent of  $\text{Cr}_2\text{O}_3$ , 0 - 5.2 percent of  $\text{ZnO}$ , 0 - 5.5 percent of  $\text{MnO}_2$ , 0 - 10.0 percent of  $\text{MgO}$ , 0 - 10.2 percent of  $\text{Na}_2\text{O}$ , 0 - 5.0 percent of  $\text{CeO}_2$ , 0 - 5.0 percent of  $\text{ZrO}_2$  and 0 - 10.2 percent of  $\text{Li}_2\text{O}$  by weight.

18. The article of manufacture of claim 17, further comprising an amount of 35.0 - 57.0 percent of  $\text{SiO}_2$ , 15.0 - 36.0 percent of  $\text{Al}_2\text{O}_3$ , 1.4 - 10.0 percent of  $\text{Fe}_2\text{O}_3$ , 15.0 - 22.0 percent of  $\text{CaO}$ , 0.6 - 15.2 percent of  $\text{TiO}_2$ , 0.3 - 11.0 percent of  $\text{K}_2\text{O}$ , 1.4 - 6.8 percent of  $\text{P}_2\text{O}_5$ , 0 - 6.0 percent of  $\text{Cr}_2\text{O}_3$ , 0 - 11.2 percent of  $\text{ZnO}$ , 0 - 11.5 percent of  $\text{MnO}_2$ , 0 - 10.0 percent of  $\text{MgO}$ , 0 - 10.2 percent of  $\text{Na}_2\text{O}$ , 0 - 5.0 percent of  $\text{CeO}_2$ , 0 - 5.0 percent of  $\text{ZrO}_2$  and 0 - 10.2 percent of  $\text{Li}_2\text{O}$  by weight.

19. The article of manufacture of claim 17, wherein the article of manufacture is a non-porous article of manufacture.

20. The article of manufacture of claim 17, wherein the density of the article of manufacture is in the range of  $2.5 \times 10^3$  to  $2.9 \times 10^3 \text{ kg/m}^3$ .

21. A poly-crystalline product that is produced by a process comprising the steps of:

a. Mixing ash particle with at least one glass forming agent and at least one crystallization catalyst,

b. Melting said ash particle, said at least one glass forming agent and said at least one crystallization catalyst to form a mixture; and

c. Cooling the resulting mixture to ambient temperature to form a homogenous, non-porous microcrystalline composition comprising  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{CaO}$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{TiO}_2$ ,  $\text{K}_2\text{O}$ ,  $\text{P}_2\text{O}_5$ ,  $\text{Cr}_2\text{O}_3$ ,  $\text{ZnO}$ ,  $\text{MgO}$ ,  $\text{Na}_2\text{O}$ ,  $\text{Li}_2\text{O}$ ,  $\text{CeO}_2$ ,  $\text{ZrO}_2$  and  $\text{MnO}_2$ .

22. The poly-crystalline product of claim 21, wherein in step C said microcrystalline composition further comprising an amount of 35.0-43.0 percent of  $\text{SiO}_2$ , 29.0-36.0 percent of  $\text{Al}_2\text{O}_3$ , 1.4 - 4.1 percent of  $\text{Fe}_2\text{O}_3$ , 16.0 - 21.0 percent of  $\text{CaO}$ , 1.3 - 15.2 percent of  $\text{TiO}_2$ , 0.6 - 8.9 percent of  $\text{K}_2\text{O}$ , 1.4 - 6.8 percent of  $\text{P}_2\text{O}_5$ , 0

- 6.0 percent of  $\text{Cr}_2\text{O}_3$ , 0 - 11.2 percent of  $\text{ZnO}$ , 0 - 1.5 percent of  $\text{MnO}_2$ , 0 - 10.0 percent of  $\text{MgO}$ , 0 - 10.2 percent of  $\text{Na}_2\text{O}$ , 0 - 5.0 percent of  $\text{CeO}_2$ , 0 - 5.0 percent of  $\text{ZrO}_2$  and 0 - 10.2 percent of  $\text{Li}_2\text{O}$  by weight.

23. The poly-crystalline product of claim 21, wherein in step C said microcrystalline composition further comprising an amount of 35.0 - 57.0 percent of  $\text{SiO}_2$ , 15.0 - 36.0 percent of  $\text{Al}_2\text{O}_3$ , 1.4 - 10.0 percent of  $\text{Fe}_2\text{O}_3$ , 15.0 - 22.0 percent of  $\text{CaO}$ , 0.6 - 15.2 percent of  $\text{TiO}_2$ , 0.3 - 11.0 percent of  $\text{K}_2\text{O}$ , 1.4 - 6.8 percent of  $\text{P}_2\text{O}_5$ , 0 - 6.0 percent of  $\text{Cr}_2\text{O}_3$ , 0 - 11.2 percent of  $\text{ZnO}$ , 0 - 11.5 percent of  $\text{MnO}_2$ , 0 - 10.0 percent of  $\text{MgO}$ , 0 - 10.2 percent of  $\text{Na}_2\text{O}$ , 0 - 5.0 percent of  $\text{CeO}_2$ , 0 - 5.0 percent of  $\text{ZrO}_2$  and 0 - 10.2 percent of  $\text{Li}_2\text{O}$  by weight.

24. The poly-crystalline product of claim 21, wherein the density of the poly-crystalline composition is in the range of  $2.5 \times 10^3$  to  $2.9 \times 10^3 \text{ kg/m}^3$ .

25. The poly-crystalline product of claim 21; wherein the poly-crystalline product is a non-porous poly-crystalline product.

26. The poly-crystalline product of claim 21, wherein said at least one glass is selected from the group consisting of  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Li}_2\text{O}$ ,  $\text{MgO}$ ,  $\text{Na}_2\text{O}$ ,  $\text{CaO}$ ,  $\text{K}_2\text{O}$ .

27. The poly-crystalline product of claim 21, wherein said at least one crystallization catalyst is selected from the group consisting of titanium dioxide, chromium oxide, zinc oxide, cerium dioxide, manganese dioxide and zirconium dioxide.

28. The poly-crystalline product of claim 21, wherein in step B said ash particle, said at least one glass forming agent and said at least one crystallization catalyst are heated at the temperature range of  $1400^\circ\text{C}$  -  $1600^\circ\text{C}$ .

29. The poly-crystalline product of claim 21; wherein said fly ash particle is about 25-90 percent, said glass forming agent is about 5-70 percent and said crystallization catalyst is about 0-15 percent on a dry basis of the poly-crystalline product.